



06/23/99

J/Reissue

DOCKET: STR 30100

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

INVENTOR:	Burroughs et al.)	PRIOR	K. Wieder
)	EXAMINER:	
)		
SERIAL NO.:	Continuation of Reissue)	PRIOR	2607
	Serial No. 07/963,915)	ART UNIT:	
)		
FILING DATE:)	DATE:	June 23, 1999
)		
FOR:	BATTERY WITH)		
	STRENGTH INDICATOR)		

JC525 U.S. PTO
09/338115
06/23/99

**CONTINUATION REISSUE PATENT APPLICATION
TRANSMITTAL LETTER**

Enclosed with this application:

- ☒ Specification, Drawings and Claims, as amended.
- ☒ Preliminary Amendment.
- ☒ Petition to the Commissioner.
- ☒ Petition to Make Special.
- ☒ Statement in Support of Petition to Make Special.
- ☒ Reissue/Declaration and Power or Attorney date October 13, 1992 (copy).
- ☒ Supplemental Reissue Declaration dated May 7 and 10, 1993 (copy).
- ☒ Second Supplemental Reissue Declaration dated December 29 and 30, 1993 (copy).
- ☒ Offer to Surrender.
- ☒ Request for Abstract of Title.
- ☒ Information disclosure Statement/PTO-1449.
- ☒ Acknowledgment postcard.
- ☒ Certificate of Mailing: ☒ Express Mail (*Specify Label No*) EL091883983US.

Fee Calculation and Transmittal

Reissue Application Filing Fee	\$ 760.00
51 Claims over the original patent	\$3,978.00
52 Claims in excess of 20	\$ 936.00
Petition Fees under 37 CFR §1.17(i) x 2	\$ 260.00
Abstract Fee	\$ 25.00
TOTAL	\$5,959.00

- ☒ A check in the amount of \$5,959.00 to cover the filing fee is enclosed. Check no. 18371.
- ☒ The Commissioner is hereby authorized to charge and credit Deposit Account No. 04-0566 as described below. A duplicate copy of this sheet is enclosed.
- ☐ Charge the amount of \$ _____ as filing fee.
- ☒ Charge or credit any under or overpayment.
- ☒ Charge any additional filing fees required under 37 CFR 1.16 and 1.17.

Dated: June 23, 1999

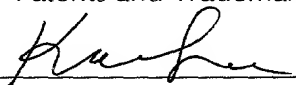

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CERTIFICATION OF MAILING UNDER 37 CFR 1.10

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Name: Kara Laudano Signature: 

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PRELIMINARY AMENDMENT

Assistant Commissioner of Patents
Washington, D.C. 20231

Dear Sir:

Upon granting a filing date to the above-identified continuation application of pending Reissue Application Serial No. 07/963,915 filed on October 20, 1992, please amend the application as follows:

In the Specification

Please insert the following cross-reference to the parent Reissue Application on page 1 after the title:

-- Cross-Reference to Related Applications

This application is a continuation of pending reissue application entitled "Battery With Strength Indicator," Reissue Serial No. 07/963,915 filed on October 20, 1992, which is a reissue application of U.S. Patent No. 5,015,544 issued on May 14, 1991. --

In the Claims

Please cancel claims 1-11 and 13-50.

Claim 12 is still pending in this continuation application.

Please add claims 51-62.

1 -- 51. A battery having a strength indicator comprising:

2 a rechargeable dry cell battery having a first terminal and a second terminal;

3 a battery strength indicator formed in a layer attached to a side of said battery

4 which undergoes a visible change when subject to a predetermined voltage

5 output of said battery and a first conductor electrically connected between one

6 end of said indicator and said first battery terminal; and

7 a battery switch comprising a resilient, non-conductive, deformable layer on a side

8 of said battery, a switch chamber disposed beneath said resilient layer, and a

9 second conductor extending from said switch chamber and connected to the

10 other end of the indicator, said portion of said second conductive lead within

11 its said switch chamber comprising a switch contact, said battery switch being

12 bias in an electrically open position,

13 whereby upon pressing of the resilient layer over said switch chamber, the switch

14 contact will be placed in electric contact with a conductive layer in electrical contact

15 with said second battery terminal, thereby placing the indicator in electrical contact

16 across the terminals of the battery to quickly indicate to the user the strength of the

17 battery.

1 52. A battery package having a battery strength indicator comprising:

2 a package frame;

3 rechargeable batteries mounted on said package frame, each of said batteries

4 having first and second terminals;

5 a battery strength indicator mounted on said package frame and electrically
6 connected to a first terminal of one of said batteries; and
7 a battery switch comprising a resilient, non-conductive layer disposed over said
8 package frame, a switch chamber disposed beneath said resilient layer, a pair
9 of switch contacts normally spaced apart in said chamber, one of said switch
10 contacts being electrically connected to said battery strength indicator and the
11 other of said switch contacts being electrically connected to a second terminal
12 of one of said batteries, said battery switch being biased in an electrically open
13 position,
14 whereby upon pressing of the resilient layer over said switch chamber, the switch
15 contacts will place said indicator in electrical contact across the terminal of said
16 batteries.

1 53. The battery of claim 12 wherein said battery strength indicator comprises:

- 2 A) a dielectric layer;
3 B) a conductive layer above or below the dielectric layer, one end of said
4 conductive layer being electrically connected to said first battery terminal and
5 the other end of said conductive layer being electrically connected to said
6 switch chamber;
7 C) a temperature sensitive color indicator material in thermal contact with the
8 conductive layer, characterized in that:
9 1) the conductive layer has
10 i) sufficient heat generating capacity to effect a change in the temperature
11 sensitive color indicator material and

ii) means to transfer sufficient heat generated by the conductive layer to the temperature sensitive color indicator material to change the color thereof and indicate voltage when the voltage indicator is in contact with a battery housing.

54. The battery of claim 12 wherein said battery strength indicator comprises a chemical redox composition which changes color when the voltage potential across the terminals of the battery crosses a pre-determined voltage.

55. The battery of claim 12 wherein said battery strength indicator comprises a liquid crystal composition that changes phases when the voltage potential across the terminals of the battery crosses a pre-determined voltage.

56. The battery of claim 12 wherein said battery strength indicator comprises a conductive layer which has a reduced cross-sectional area in contact with a heat sensitive color indicating material adapted to undergo a color change when the temperature of the reduced cross-sectional area of the conductive layer rises to a pre-determined temperature when the voltage potential across the terminals of the battery crosses a pre-determined voltage.

57. The battery of claim 12 wherein said battery strength indicator comprises a light emitting diode that undergoes a visible change when the voltage potential across the terminals of the battery crosses a pre-determined voltage.

1 58. The battery of claim 51 wherein said battery strength indicator comprises

2 A) a dielectric layer;

3 B) a conductive layer above or below the dielectric layer, one end of said
 4 conductive layer being electrically connected to said first battery terminal and
 5 the other end of said conductive layer being electrically connected to said
 6 switch chamber;

7 C) a temperature sensitive color indicator material in thermal contact with the
 8 conductive layer, characterized in that:

9 1) the conductive layer has

10 i) sufficient heat generating capacity to effect a change in the temperature
 11 sensitive color indicator material and

12 ii) means to transfer sufficient heat generated by the conductive layer to
 13 temperature sensitive color indicator material to change the color
 14 thereof and indicate voltage when the voltage indicator is in contact
 15 with a battery housing.

1 59. The battery of claim 51 wherein said battery strength indicator comprises a
 2 chemical redox composition which changes color when the voltage potential across
 3 the terminals of the battery crosses a pre-determined voltage.

1 60. The battery of claim 51 wherein said battery strength indicator comprises a
 2 liquid crystal composition that changes phases when the voltage potential across the
 3 terminals of the battery crosses a pre-determined voltage.

1 61. The battery of claim 51 wherein said battery strength indicator comprises a
2 conductive layer which has a reduced cross-sectional area in contact with a heat
3 sensitive color indicating material adapted to undergo a color change when the
4 temperature of the reduced cross-sectional area of the conductive layer rises to a pre-
5 determined temperature when the voltage potential across the terminals of the battery
6 crosses a pre-determined voltage.

1 62. The battery of claim 51 wherein said battery strength indicator comprises a
2 light emitting diode that undergoes a visible change when the voltage potential across
3 the terminals of the battery crosses a pre-determined voltage. - -

REMARKS

The parent reissue application was filed to provoke an interference which was declared in 1994, now Interference No. 103,036 of which Burroughs et al. is the senior party. Originally filed claims 13-50 were designated as corresponding to the count by Examiner Wieder. Claims 51-63 were added in the prosecution of the parent reissue application by an amendment filed on September 23, 1993. Prior to the declaration of interference, claims 1-12 and 52-63 of the parent reissue were deemed as not corresponding to the count in an office action dated November 29, 1993, para. 7, and to have overcome the rejections under 35 USC §§112 and 103.

In this continuation application, applicants have now canceled claims 1-11 and 13-50 of the parent reissue and added new claims 51-62 which are identical to claims 52-63, respectively, in the amended parent reissue. It is respectfully requested that the claims which do not correspond to the count, claims 12 and 51-62 of the instant application, and are not at issue in the interference, may issue as a separate reissue patent. Parent claims 1-12 and 52-63, now claims 51-62 of the instant continuation reissue application, were found to have overcome the §§112 and 103 rejections cited by Examiner Wieder and as such are allowable subject matter. A petition under 37 CFR §1.177 with fee is enclosed so that this continuation may issue separately from the parent reissue. No new matter has been added. When prosecution reopens, applicants will file an amendment in the parent reissue application canceling claims 1-12 and 52-63 to avoid a double patenting rejection.

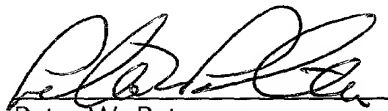
A copy of the original reissue declaration and its supplements filed with the parent reissue application is enclosed with the filing of the instant continuation

application. Applicants allege the same errors as in the parent reissue and these errors will be corrected with the claims in the instant application which are identical to claims filed in the parent reissue. Thus, applicants submit that a new reissue declaration is not required.

Additionally, the undersigned believes that there is actual and on-going infringement of at least some of claims 12 and 51-62 of the instant application after a rigid analysis of the claims with a device currently in the marketplace. A Petition to Make Special Because of Actual Infringement along with the appropriate fee is included as well.

Applicants respectfully requests entry of this preliminary amendment and request that the continuation be allowed to issue as a separate reissue patent since claims 12 and 51-62 have been deemed patentable and are not at issue in Interference No. 103,036.

Respectfully submitted,

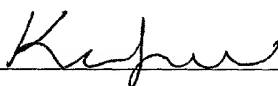

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Name: Kara Laudano

Signature: 

DOCKET NO. STR 30100
DELIO & PETERSON, LLC

CONTINUATION REISSUE APPLICATION

of

Reissue Application Serial No. 07/963,915

filed October 20, 1992, which is a Reissue Application for

U.S. Patent No. 5,015,544, issued May 14, 1991

based on Serial No. 308,210 filed February 8, 1989

by

James R. Burroughs

and

Alan N. O'Kain

for

BATTERY WITH STRENGTH INDICATOR

CERTIFICATION OF MAILING UNDER 37 CFR 1.10

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Name: Kara Laudano

Signature: *Kara Laudano*

[54] BATTERY WITH STRENGTH INDICATOR

[57] ABSTRACT

A battery strength indicating and switch means on a battery which is coupled across the terminals of the battery and which is provided with an indicating means to indicate the strength of the battery and in addition, the battery strength indicating means is also provided with an in-line switch which can easily be depressed to complete the circuit so as to place the indicator means across the terminals of the cell and display the charge of the battery.

BATTERY WITH STRENGTH INDICATOR

RELATED APPLICATIONS

Applicants have filed related U.S. patent application 5
Ser. No. 160,143 on Feb. 25, 1988, on IMPROVED
FLASHLIGHT WITH BATTERY TESTER.

FIELD OF THE INVENTION

The present invention relates to an improved battery 10
having a built-in strength indicator device for determin-
ing the strength, voltage, or capacity of the battery.
More particularly, the present invention relates to a
battery having an indicator cell which visually indicates
when the battery is above or below a predetermined 15
voltage value, an LED array which indicates when the
battery is above or below a predetermined voltage
value, or a redox cell which indicates when the voltage
output is above or below a predetermined voltage by a
color change. 20

BACKGROUND OF THE INVENTION

Batteries are employed extensively in this country
and abroad for automobiles, home uses, industrial uses,
recreational uses, and military uses. A battery is nor- 25
mally tested by measuring its voltage output without a
load. If the voltage is below a predetermined value, and
the voltage characteristics of the battery with respect to
the battery's capacity are known, one can determine
whether the battery has sufficient capacity to perform a 30
desired function. A more accurate indication of the
battery's condition can be determined by noting the
voltage drop of the battery under a load. A well-
charged battery will experience only a slight voltage
drop under a load, whereas a depleted battery will un- 35
dergo a significant voltage drop under a load. For a
wet-cell battery, the work capacity of the battery can
frequently be determined by measuring the specific
density of the electrolyte.

A dry-cell battery does not have a reservoir liquid 40
electrolyte; thus, its capacity cannot be determined by
taking specific gravity measurements. In addition, volt-
meters are expensive, as are devices for measuring the
voltage output of a battery, both under a load and under
no load. Accordingly, most batteries are purchased or 45
used without the purchaser/user knowing the true con-
dition of the battery.

Recently, the manufacturer of DURACELL-brand
batteries has been date-marking its packages to indicate
by which date the battery should be in use. Although 50
this date-stamping may be of some benefit to purchas-
ers, it does not tell the purchaser the actual condition of
the battery. Moreover, date-stamping of the package
does not include date-stamping of the battery; thus, the
purchaser has no idea of the use-date of a particular 55
battery once it has been removed from the package.

Our related U.S. patent application identified above
discloses a flashing with a built-in battery tester having
a voltmeter, ammeter, or visual-indicating chemical or
LED cell to indicate when the battery's voltage output 60
is above or below a predetermined value.

Flashlights, portable lanterns, portable radios and
television, cameras, video recorders, portable dictating
machine, and the like are used extensively in this coun-
try and abroad. Almost every home and business has at 65
least one flashlight or portable lantern and a radio.
Many home and businesses have numerous devices,
such as recorders, portable radios and televisions, video

recorders, calculators, cameras, and the like, which utilize batteries for their energy source. Some of the devices, such as flashlights, are used on an infrequent basis, that is, during an emergency situation where there has been a power failure or when it is not convenient to use, a light source powered by conventional household current, such as for outdoor use or use in an unlighted attic or crawl space. Other devices, such as portable radios, are used extensively. The majority of these battery powered devices use dry-cell nonchargeable batteries. Nonrechargeable alkaline batteries sold under the trademarks EVEREADY, DURACELL, RAY-OVAC, and the like, have a number of advantages over rechargeable batteries. On a weight-to-weight and volume-to-volume basis, the alkaline battery can supply three to four times the wattage of a rechargeable battery. In addition, nonrechargeable dry-cell rechargeable batteries put out a higher voltage than dry-cell rechargeable batteries. Many dry-cell rechargeable batteries, even if not in use, have to be periodically charged to keep the batteries from falling below a defined charge level to prevent permanent damage to the batteries. Alkaline batteries, which are used frequently, can have a shelf or storage life of from three to five years. During this period, no maintenance of the battery is required. In contrast, most rechargeable batteries wet-cell and dry-cell will completely discharge within six months or less of their last recharge.

Most individuals test their batteries by turning on the device in which the batteries are installed. If the device operates, the individual is normally satisfied that the batteries are operational. Some individuals will test the batteries on a battery tester to determine the condition of the batteries. Some individuals will even test the batteries under both loaded and unloaded conditions to measure the voltage drop. Although it is not complicated to test batteries, it is time consuming to disassemble a device, remove the batteries, test the batteries, and, if they pass the test, reinstall the batteries in the device. It is normally not possible to test new batteries at the time of purchase because of the battery protective packaging.

Accordingly, it is the object of the present invention to provide an improved battery having a built-in battery-strength indicator which permits one to immediately determine the battery's strength or condition. Thus, with the improved battery of the present invention, a user can quickly and effortlessly determine the strength or condition of a battery. When a battery is easily tested, as the battery of the present invention, the user of the battery is more likely to routinely check condition of the battery.

SUMMARY OF THE INVENTION

The present invention is directed to an improved battery comprising;

- (a) a battery; and
- (b) a battery-strength indicator means to indicate the strength of the battery when electrically connected to the battery.

Optionally, the battery will include a switch means adapted in an "on" position to electrically connect and complete a circuit between the battery and the indicator means.

The battery-strength indicator means can comprise:

- (a) a nonconductive base layer;

- (b) a nonconductive top layer attached to the base layer, a portion of the top layer and base layer forming a chamber therebetween;
- (c) first and second conductive means separately and independently positioned between the top layer and the base layer and extending into the chamber, the ends of the conductive means in said sealed chamber forming electrodes, the other ends of the conductive means adapted to electrically connected to the battery; and
- (d) indicator means in said sealed chamber adapted to undergo a visible change when the voltage potential across the electrode exceed or crosses a predetermined voltage.

The indicator means can be a liquid-crystal composition that changes phases when the field between the electrodes or plates exceeds or crosses a predetermined voltage value. Preferably the chamber is sealed.

In an alternative embodiment of the present invention, the battery strength indicator means comprises:

- (a) a first nonconductive layer;
- (b) a second nonconductive layer attached to the first layer, a portion of the first and second layers forming a chamber therebetween, said chamber having first and second internal opposing walls;
- (c) a third nonconductive layer having a high dielectric constant attached to the first internal wall of said chamber;
- (d) a first conductive plate means sandwiched between the third insulating layer and the first internal wall and isolate from the chamber.
- (e) a second conductive plate means on the second internal wall;
- (f) first and second conductive means separately and independently positioned between the first and second nonconductive layer, the ends of the conductive means electrically connected to the first and second conductive plate means respectively, the other ends of the conductive means adapted to be electrically connected to the battery; and
- (g) a liquid-crystal composition in said sealed chamber adapted to undergo a visible phase change when the electric field between the first and second plate means exceeds or crosses a predetermined value.

Preferably the chamber is sealed.

One embodiment of the switch means of the present invention comprises:

- (a) a nonconductive base layer;
- (b) a resilient nonconductive top layer attached to the base layer, a portion of the top and base layers forming a chamber having first and second internal spaced apart opposing wells;
- (c) a first contact means on the first internal wall of the chamber;
- (d) a second contact means on the second internal wall of the chamber;
- (e) first and second conductive layers independently and separately sandwiched between the top layer and the base layer and connected to the first and second plate means respectively, the top layer about the chamber adapted to be pushed toward the base layer so that the first and second contact means come in contact to permit current to flow from the first conductive means to the second conductive means.

In an alternative embodiment of the switch means of the present invention, the switch means comprises:

- (a) a nonconductive base layer;
- (b) a resilient nonconductive top layer attached to the base layer, a portion of the top and base layers forming a chamber having first and second internal spaced apart opposing walls;
- (c) first and second spaced apart conductive contact means on the first internal wall of the switch chamber;
- (d) third conductive contact means on the second internal wall of the chamber; and
- (e) first and second conductive means independently and separately sandwiched between the top layer and base layer and connected to the first and second conductive contact means respectively, the top layer about the chamber adapted to be pushed toward the base layer so that the third conductive contact means contacts the first and second conductive contact means to complete an electrical connection between the first and second conductive contact means.

In another embodiment of the present invention, the battery-strength indicator means comprises:

- (a) a first nonconductive layer;
- (b) a second nonconductive layer attached to the first nonconductive layer, a portion of said first and second nonconductive layers forming a chamber therebetween;
- (c) a conductive layer sandwiched between said first and second nonconductive layers, the conductive layer reduced to a small cross-sectional area in the chamber; and
- (d) a heat sensitive color-indicating material in said sealed chamber that is adapted to undergo a color change when its temperature exceeds or crosses a predetermined value, said conductive layer in the chamber rising to a predetermined temperature when the voltage of the current flowing there-through exceeds a predetermined value.

In a further embodiment of the present invention, the battery-strength indicator means comprises:

- (a) a first nonconductive layer;
- (b) a second nonconductive layer attached to the first nonconductive layer, a portion of said first and second nonconductive layers forming a chamber therebetween;
- (c) a conductive layer sandwiched between said first and second nonconductive layers, the conductive layer reduced to a small cross sectional area in the chamber;
- (d) a pyrotechnic material contained within said chamber and adapted to decompose when the temperature of the first section of the conductive layer in the chamber exceeds a predetermined temperature, the first section of the conductive layer adapted to exceed said predetermined temperature when the voltage of the current through the conductive layer in the chamber exceeds a predetermined value.

In a further embodiment of the present invention, the battery-strength indicator means comprises:

- (a) a first nonconductive layer;
- (b) a second nonconductive layer attached to the first nonconductive layer, a portion of said first and second nonconductive layers forming a chamber therebetween; and
- (c) a conductive layer sandwiched between said first and second nonconductive layers, the conductive layer reduced to a small cross sectional area in the

chamber such that when the voltage of current flow through the conductive layer in the chamber exceeds a predetermined value, the temperature of the conductive layer in the chamber exceeds the melting temperature of the conductive layer causing the conductive layer to melt and form an open circuit. 5

The invention also comprises an improved battery package having a battery-strength indicator means comprising: 10

- (a) at least one battery;
- (b) a battery-strength indicator means comprising:
 - (i) a battery-strength indicator device for indicating the strength of said battery when electrically connected to said battery; and 15
 - (ii) conductive means adapted to electrically connect said indicator device to said battery; and
- (c) packaging means for said battery and battery strength indicator means. 20

Optionally, the improved batteries can have switch means to electrically connect the battery strength indicator to the battery. Preferably the chambers of the battery strength indicators are selected chambers. 25

BRIEF DESCRIPTION OF THE DRAWINGS 25

FIG. 1 is a top view of a battery-strength indicator device of the present invention;

FIG. 1A is a top view of a battery-strength indicator device of the present invention with a switch; 30

FIG. 2 is a perspective view of a battery of the present invention having a battery-strength indicator device;

FIG. 3 is a vertical, sectional view along lines 3—3 of FIG. 1; 35

FIG. 4 is a top plan view of a battery-strength indicator device of the present invention;

FIG. 5 is a vertical, sectional view along line 5—5 of FIG. 4;

FIG. 6 is a vertical, sectional view of a switch of the present invention with the switch in the off position; 40

FIG. 7 illustrates is a vertical, sectional view of a switch of the present invention with the switch in the "on" position;

FIG. 8 is a vertical, sectional view of an alternative switch of the present invention; 45

FIG. 9 is a vertical, sectional view of an alternative embodiment of the battery-strength indicator device of the present invention;

FIG. 10 is a top plan view of another alternative embodiment of the battery-strength indicator device of the present invention; 50

FIG. 11 show a top plan view of still a further embodiment of the battery-strength indicator device of the present invention; 55

FIG. 12 is a perspective view of the battery packaging of the present invention having a battery-strength indicator device;

FIG. 13 is a schematic diagram of the battery packaging circuitry of the present invention having a battery-strength indicator device; 60

FIG. 14 is a vertical, sectional view of an alternative embodiment of the switch of the present invention;

FIG. 15 is a vertical, sectional view of another embodiment of the battery-strength indicator device of the present invention; and 65

FIG. 16 is an enlarged, sectional view within encircled line 16 of FIG. 15.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIG. 1, a battery-strength indicator device 10 of the present invention is illustrated. The indicator device has an indicator chamber, cell or bubble 12 formed in strip 16. Preferably the cells of the present invention are sealed cells. Conductive layers 14 run the length of the strip into the indicator bubble to form spaced apart electrodes. The indicator bubble contains an indicating material 17 which undergoes a visible change when the voltage potential across the indicator cell exceeds a predetermined value. At least one side of the strip 16 is transparent or translucent.

The improved battery 18 of the present invention is illustrated in FIG. 2. The battery has an anode 20 and a cathode at its base (not shown). The indicator device 10 is attached to the side of the battery, with the ends of the device connected to the anode 20 and the cathode.

If the device is a constant-drain device, that is, the device is on continuously, the indicator cell undergoes a visible change when the output voltage of the battery drops below a predetermined value. In an alternative embodiment of the invention, the battery has the indicator device of FIG. 1A, which includes a strip 16, conductive leads 14, an indicator cell 12, and a switch 24. The switch is biased to be in an off position, and, thus, the indicator device is only actuated when the switch is on, thus preventing a constant drain on the battery.

Referring to FIG. 3, the indicator device 10A comprises a first layer 30, a second layer 32, and a conductive layer or lead 14 sandwiched between the first and second layers. The end of the conductive leads extend into the indicator chamber or cell 12, which is filled with an indicator material 33. The ends of the conductive leads form electrodes 36. The second layer of the device of FIG. 3 is formed with the bulge 37 which forms one side of the cell. The other side of the cell is formed by the first layer. The first layer can be a clear material, a translucent material, or an opaque material. The second layer is preferably a clear or translucent material. The first layer can be an opaque material as long as the bulge area is clear or translucent. If the first layer is opaque, the inner side 31 of the first layer can be coated with a reflective material such as aluminum or aluminum foil, or a highly reflective white material to enhance visibility of the indicator material.

The indicator material can be any material that will undergo a visible change, such as a color change, when the voltage potential across the electrodes exceeds or drops below a predetermined voltage. For example, the material can be a redox composition, such as the composition in the Sterling U.S. Pat. No. 1,497,388, or the compositions disclosed by H.A. Fales and F. Kennym INORGANIC QUANTITATIVE ANALYSIS, 1939, pp. 391-393, or like. Alternatively, the composition can be a liquid-crystal composition, such as one of the compositions disclosed in Klirk-Othmer, ENCYCLOPEDIA OF CHEMICAL TECHNOLOGY, 3rd Ed., John Wiley & Sons, Vol. 7, pp. 724-751 and Vol. 14, pp. 395-427.

The voltage color-indicating device of the present invention comprises a sealed cell having at least one transparent or translucent window. The cell is filled with an aqueous or non-aqueous composition, such as an aqueous phenolphthalein solution. Two spaced-apart electrodes of the cell are in contact with the color-indicating solution. When a voltage potential is induced

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across the electrodes, a redox reaction occurs which can cause a color change in the color-indicating solution. Each solution has its own unique threshold voltage wherein the redox reaction will commence. If the voltage of the battery is below that threshold voltage, no redox reaction will occur and there will be no color change.

An alternative embodiment of the battery-strength indicator device 10B of the present invention is illustrated in FIGS. 4 and 5. The indicator device 10B has a first layer 30, and a second layer 32a, and conductive leads or layers 14 sandwiched therebetween. The second layer 32a has a depression or cavity 38 which defines one side of the indicator cell 12; the other side of the cell being defined by the inner surface 31 of the first layer 30. The cavity is illustrated with curved surfaces, it can also have straight sides arranged in perpendicular or nonperpendicular fashion. One or both of the layers are transparent or translucent. Although the drawing illustrates the layers as being relatively thick, in actual practice the layers can be quite thin, such as 1 or 2 mils, with the cell having a maximum height or depth of 0.5 or 1 mil. One embodiment of the switch 44 of the present invention is illustrated in FIGS. 6 and 7. The switch 44 has a base layer 46 and a resilient top layer 48, which is attached to the base layer. Conductive leads or layers 50a and 50b are sandwiched between the two layers. The conductive layer 50a on the left side of the device is separated from the conductive layer 50b on the right side of the device by spacing 51. A portion of the top layer is bulged out to form a bubble element 56. A conductive strip or coating 54 is attached to the inner side 55 of the bubble element. The bubble element is biased away from the base layer 46 as shown in FIG. 6 so that the conductive strip or coating does not come in contact with the switch contacts 52. Thus, the switch is normally in the off position. When the bubble element is pressed downwardly towards the base layer as shown in FIG. 7, the conductive strip 54 contacts the switch contacts 52; thus bridging the contacts and permitting current flow across the contacts between the conductive leads or layers 50a and 50b, as illustrated FIG. 7. When pressure is removed from the bubble element, the bubble element biases away from the base layer, breaking contact between the two contacts 52.

An alternative embodiment of the switch 44A of the present invention is illustrated in FIG. 8. This switch has a base layer 46, a resilient top layer 48, and conductive leads or layers 50 sandwiched between the two layers. The top layer is bulged out to form a bubble element 56. The switch contacts 52 are located on the inner sides of the bubble element. A conductive strip 54 or coating is attached to the inner side of the base layer 46. This switch operates in the same manner as does the switch of FIGS. 6 and 7. The bubble element is depressed to have the switch contacts 52 make contact with the conductive strip 54; thus, electrically bridging the two contacts. The bubble element is biased away from the top layer so that the switch is normally in an off position. When pressure is removed from the bubble element, the bubble element biases away from the conductive strip; thus, breaking contact between the switch contacts and the conductive strip.

Another embodiment of the battery-strength indicator device of the present invention is illustrated in FIG. 9. The device 10C has a first layer 30 and a second layer 32. Conductive layers 14a and 14b are independently and separately sandwiched between the first and second

layers on the left and right sides respectively of the device. A portion of the first layer is formed into a bulge 37 to form the indicator cell 12. A plate or electrode 60a is attached to the inner surface 31 of the top layer within the cell and is electrically connected with conductive layer 14a. A second plate or electrode 60b is attached to the inner side 35 of the second layer 32 within the indicator cell and is electrically connected to the conductive layer 14b. The indicator cell is filled with an indicator material 17, such as the material described above. At least one of the layers and its attached plate are transparent or translucent (or one of the layers is transparent or translucent and its attached plate is extremely thin) so that change to the indicator material are visible.

- 15 The basic architecture of the indicator device of FIG. 9 can also be utilized for another embodiment of the switch of the present invention. When the architecture is employed as a switch, the bulge 37 is biased away from the second layer 32, and the indicator cell is not filled with an indicator material. Two switch contacts replace the electrodes 60a and 60b and the switch operates when the bulge is depressed downwardly to make the contact between the switch contact attached to the inner side of the first layer and the switch contact mounted on the inner side of the second layer.

Another embodiment of the battery-strength indicator device of the present invention is shown in FIG. 10. The indicator device 10D is a strip like device having first and second superimposed layers 30 and 32 which are attached together in the same manner as strips 30 and 32 in FIG. 3. At least one of the strips is transparent. Conductive layers 64 are sandwiched between the first and second layers. The conductive layer is reduced to a small cross-section 65 in the indicator zone 66. Within the indicator zone, the conductive layer is covered with a small amount of a pyrotechnic chemical 68 sensitive to heat. Surrounding the pyrotechnic chemical is a color indicating, heat-sensitive material 70 which will undergo a visible color change, either permanent or temporary, when the material is heated to at least a predetermined temperature. This battery-strength indicator device is a one-shot device; the pyrotechnic chemical will only decompose or react once. The pyrotechnic chemical undergoes rapid decomposition when it is heated to a predetermined temperature. The resistance of the conductive layer in the reduced cross-sectional area 65 is selected such that current flow at a minimum predetermined voltage through the conductive layer will raise the area to a predetermined temperature which will cause the pyrotechnic chemical to decompose or otherwise react. The pyrotechnic chemical in turn will raise the temperature of the color-indicating, heat sensitive material to the predetermined temperature for color change.

- 55 Although the indicator device of FIG. 10D is shown with a color-indicating, heat-sensitive material, the device can also be fabricated with the pyrotechnic chemical alone, thereby causing a slight charring to the strip which is noticeable. One of the strips can also be made of a material that is sensitive to temperature and will undergo a visible change when the temperature exceeds a predetermined value. Alternatively, the device can be fabricated without the pyrotechnic chemical, relying on the color-indicating, heat-sensitive material alone to indicate whether the battery has a predetermined minimal voltage output. If the color indicating, heat-sensitive material undergoes a non-permanent color change when exposed to a predetermined temperature, then the

battery-strength indicator device of FIG. 10D can be used repeatedly to determine if the output voltage of the battery meets a predetermined voltage level.

A further embodiment of the battery-strength indicator device of the present invention is illustrated in FIG. 11. The battery-strength indicator device 10E has first and second layers 30 and 32 which are sandwiched together like layers 30 and 32 in FIG. 3. The conductive layers 64 are sandwiched between the first and second layers. The conductive layer is reduced to a small cross-section area 75 within the indicator cell 66. The resistance of the conductive layer and the cross-sectional area 75 are selected such that the current flow of a predetermined minimum voltage potential through the conductive layer will melt the area 75 in the fashion of a fuse element, causing the conductive strip area 75 to become an open circuit. The vaporization of the melted conductive strip forms a visible sign that the area 75 was heated to a predetermined temperature which can only be achieved when the device is subject to a predetermined minimum voltage.

Another embodiment of the invention is shown in FIGS. 12 and 13. A battery package 84 comprises two batteries 18 mounted on a package frame 82. Conductive leads 14a and 14b are affixed to the base of the frame in electrical contact with the cathode 22 of the battery. A conductive lead 14 connects the leads 14a and 14b with a battery strength-indicator 10, such as the ones described herein. A conductive layer 50 connects the indicator 10 with the switch 44 which in turn is connected to a conductive T-connection 86. The T-connection is electrically connected to the battery anodes 20 via conductive layer 50 and conductive flaps 86. The package is intended to be covered with a transparent cover giving physical access to the switch 44 and visual access to the indicator 10. In the embodiment of FIG. 12 the batteries are in parallel. FIG. 13 illustrates the circuitry of a battery package containing two batteries that are connected in series to the switch 44 and indicator 10.

In the preferred embodiment of the conductive leads, switch and indicator are layers attached to the package frame. The conductive leads may be printed or silk screened directly on the package frame. The package frame can be the base nonconductive layer for the switch 44 and indicator 10.

Another embodiment of the switch 44 of the present invention is illustrated in FIG. 14. The switch has a base layer 46 and a top layer 48, which is attached to the base layer. Conductive leads or layers 50a and 50b are sandwiched between the two layers. The conductive layer 50a on the left side of the device is formed into switch contact 62a in chamber 40 and the conductive layer 50b on the right side of the device is formed into switch contact 52b in the chamber. A portion of the top layer and bottom layer are bulged out top from bubble elements 56a and 56b. The bubble elements are biased away from each other so that the switch contacts do not come in contact. Thus, the switch is normally in the off position. When the bubble elements are pressed together as shown by the arrows in FIG. 14, the switch contacts come in contact permitting current flow across the contacts and the conductive leads or layers 50a and 50b. When pressure is removed from the bubble elements, the bubble elements bias away from each other, breaking contact between the two switch contacts.

The present invention permits the user of a battery to quickly determine whether the capacity of the battery is above or below a given point without the use of a volt-

meter and/or ammeter. The approximate capacity of a battery can be determined by the battery's no load output voltage. The indicator device of the present invention can be fabricated so that it indicates a particular no-load voltage threshold. For example, one can select a voltage threshold which is indicative that the battery is about 20% exhausted, or about 50% exhausted—whatever is suitable for the intended purpose.

The indicator having a liquid-crystal composition comprises a sealed, fully-enclosed cell containing the liquid-crystal composition. Preferably, one side of the cell will be transparent, and not merely translucent. The base layer of the liquid-crystal indicator cell can be a high-dielectric material, optionally coated with a dielectric mirror in contact with the liquid-crystal composition. The top layer is preferably transparent and, optionally, has a transparent, conductive coating applied to the surface in contact with the liquid-crystal composition. A voltage differential is induced across the liquid-crystal composition to either the base high-dielectric material or the high-dielectric transparent top layer to induce electric field. An electric field change can cause changes in the optical properties of liquid crystals, such as when a liquid crystal changes from a nematic phase to a smectic phase. Such field are easily achieved, even with small voltage inputs from batteries, by employing a high-dielectric base material and/or a high dielectric top layer material. Thus, when the liquid-crystal detector of the present invention is in a non-energized state, it will have one optical appearance characteristic of the 'at rest' phase of the liquid crystal. When the indicator device is activated, and a field is generated across the liquid-crystal composition, the liquid-crystal composition will transform into another phase. Alternatively, the indicator can remain in an "always on" condition and provide a constant indication of battery strength. If batteries do not have sufficient voltage to achieve the threshold high-dielectric field, thereby changing the liquid-crystal composition from one phase to the other, no change will be observed. Thus, each liquid-crystal indicator cell will be tailored by controlling the thickness of the dielectric material in the sandwich, the distance between the plates or electrodes, and the dielectric composition. Typical liquid-crystal compositions that can be employed include methoxybenzylidenebutylaniline and terephthal-bis-p-butyl-aniline.

In the indicator device of FIG. 15, the electrodes 62b and 62a are independently and separately sandwiched between the first high dielectric constant layer and the third nonconductive layer 30 and 34 and the first layer and second nonconductive layers 30 and 32, respectively. A bulge extending outwardly from the first layer is formed in the second layer to form an indicator cell 40. Within the cell on the inner side of the second layer 32 and a plate 62a is attached or coated and electrically connected to lead 14b. Plate 62b is positioned below the indicator cell between the first and third layers and is electrically connected to conductive layer 14a. The indicator cell 12 is filled with a liquid-crystal composition 40. The second layer and plate 62a and/or the first and third layers and plate 62b are transparent or translucent so that changes to the liquid-crystal composition 40 are visible. The bottom of the chamber can include a highly reflective coating or the like to enhance observation of the changes to composition 40. The arrangement of the first, second, and third layers of

the conductive layer 14a is shown in the enlarged, sectional view of FIG. 16.

Other constructions of the battery strength indicators and switches are contemplated within the scope of this invention. For example, in indicator can be fabricated 5 with conductive top and base layers which sandwich a nonconductive layer. A cell is formed between the top and bottom layers as described herein. The nonconductive layer does not extend into the cell; this layer, however, does electrically insulate the top layer from the 10 bottom layer. The cell is filled with an indicator material as described herein and the top and bottom layer are independently adopted to be connected to different poles of a battery. The top and/or bottom layer are transparent or translucent. 15

Another indicator embodiment contemplated by the present invention is similar to indicator 10D of FIG. 10. This alternative embodiment has top and base layers sandwiching a conductive layer that is reduced to a small cross-sectional area in a indicator region of the 20 indicator. The top layer and/or base layer undergo color changes when the temperature crosses a predetermined threshold. The conductive layer in the indicator region is adopted to exceed the predetermined temperature threshold when the voltage potential across the 25 conductive layer exceeds a predetermined voltage.

In another embodiment of the indicator, the indicator can use a BIOMETAL material of TOKI AMERICAN TECHNOLOGIES, INC. of Irvine, Calif. BIOMETAL material is a shape memory alloy which changes 30 its internal structure at a predetermined temperature and takes on an entirely new space. A BIOMETAL material can be used in place of the pyrotechnic material or color indicating material of the device 10D of FIG. 10x to indicate whether the battery has a predeter- 35 mined voltage.

The present invention can be used with a dry cell battery or with a wet-cell battery and with both rechargeable and nonrechargeable batteries. However, for purposes of convenience, the invention has been 40 described herein with respect to a dry-cell battery.

The modern nonrechargeable alkaline dry-cell battery has a declining output voltage over its useful life. A new battery has an output voltage of about 1.60 volts. After one hour of continuous use, a battery's voltage 45 output (no-load) drop to between 1.40 volts and 1.45 volts. Thereafter, for the majority of the battery's useful life, the battery's no-load voltage gradually decreases in a somewhat linear fashion. As a battery approaches the end of its useful life, the no-load voltage drops to about 50 1.0 volt. However, the battery still has some capacity and can be marginally used in this weakened conditioned for very brief periods of time. When the battery's voltage drops below 1.0 volt, the battery is near the end of its life, and the remaining capacity of the battery is 55 very limited. Near the point of exhaustion, the battery's output voltage rapidly drops from about 1.0 volt to about 0.5 or 0.6 volt.

The light-output candle-power of a portable lantern or flashlight bulb is somewhat sensitive to the battery 60 voltage. Incandescent lamps are designed to operate optimally at a specific voltage. If the voltage is appreciably exceeded (such as by 50%) for any period of time, the film of the lamp will rapidly melt or vaporize, destroying the lamp. Most lamps are designed for volt- 65 ages in increments of 1.2 volts. Thus, portable-lantern incandescent lamps are designed optimally for an output voltage of about 4.8 volts (a 6-volt lantern), and

single-cell, double-cell, triple-cell, four-cell, and five-cell flashlight incandescent lamp are designed for an output voltage of 1.2, 2.4, 3.6, 4.8, and 6.0 volts respectively. However, flashlight and lantern bulbs will operate effectively over a broad range. For example, a two-cell lantern bulb or lamp will operate effectively from about 3.2 volts to about 2.0 volts. However, when the voltage of each battery drops below 1.0 volt, the output of the incandescent lamp is noticeably affected, and the color of the emitted light shifts from a yellow-white light to a yellow-red light.

Three sets of batteries were tested in three identical flashlights, with the batteries being switched between the flashlights on a routine basis. The results of the tests are shown in the following tables. (The Roman numerals I, II, and III indicate the flashlight, and the numbers 1A, 1B, 2A, 2B, 3A, and 3B indicate the individual batteries). The first set of batteries (1A and 1B) were ENERGIZER brand alkaline batteries; the second set (2A and 2B) were DURACELL brand alkaline batteries, and the third set (3A and 3B) were EVEREADY brand zinc-carbon batteries. The batteries were "D" size batteries. Battery 2A failed after 32 hours and was replaced with a 3-year old DURACELL alkaline battery having a no-load voltage of 0.99 volt.

The flashlights were two-cell flashlights having incandescent lamps. The incandescent lamps were rated at 1.2 volts and 0.5 amp. The cold-filament internal resistance of the incandescent lamps was about 0.4 amp. The hot-filament internal resistance of the incandescent lamps was not measured.

Each flashlight was loaded with a set of batteries and turned on. From time to time, the flashlights were turned off and the no-load output voltage of the batteries was measured. On a periodic basis, the output voltage of the batteries under load was also measured. The tests were not run on a continuous, 24-hour basis, but were run for periods of approximately 12 hours during the first two days, about 3 hours the third day, about 7 hours the fourth day, about 6 hours the ninth day, and 20 minutes the tenth day. No tests were conducted during the fifth, sixth, seventh and eighth days. The results show that the useful life of a battery is near exhaustion when the voltage of the battery has fallen below 1.0 volt. After the voltage of the battery drops below 1.0, the discharge rate of the battery (indicated by the voltage drop) can exceed 0.5 volt in a half-hour.

It appears, from the tables, that the useful life of the 1A and 1B batteries is about 28 to 29 hours and the half-life is about 14 hours where the output voltage is about 1.2 volts. When the output voltage of the batteries is about 1.3 volts, the batteries have about 75% of their operating life remaining. When the voltage of the batteries is about 1.1 volts, the batteries have about 25% of their useful life remaining.

The 2A and 2B batteries appear to have a useful life of about 23 hours and a half-life of about 12 hours where the output voltage is about 1.2. When the output voltage of the batteries is about 1.3 volts, the batteries have about 75% of their useful life remaining. When the output voltage drops to about 1.15 volts, the batteries have only about 25% of their remaining useful life.

Batteries 3A and 3B, which are zinc-carbon batteries (LeClanche cell), had a much shorter life span than the alkaline batteries. These batteries had a useful life of about 7.5 hours, with a half-life of about 3.5 to about 4 hours where the output voltage is about 1.2 volts. When the batteries' output voltage is about 1.3 volts, the bat-

teries have about 75% of their remaining useful life. When the batteries' output voltage drops to about 1.1 volts, the batteries only have about 25% of their useful life remaining.

When the no-load output voltage of the batteries dropped below 1.0 volt, all the batteries exhibited rapid voltage drops. When the batteries reached the end of their useful life, the flashlights were turned off and the batteries were allowed to rest. Surprisingly, the batteries' output voltage would rebound and the batteries could be operated for brief periods. As this cycle of rest and use was continued, the batteries' ability to rebound decreased and the batteries experienced much more rapid voltage drops under the load.

The tests indicate that, when the batteries are fresh, the total voltage drop of a pair of batteries in series is somewhere from about 0.45 to about 0.65 volts; that is, the total output voltage of the two batteries in the flashlight under no-load will be about 3 volts, and under the load will be about 2.5 volts. As the batteries approached their half-life, the voltage drops for the two batteries increased to about 0.75-about 0.95 volt. When the batteries approached the end of their useful life, the voltage drop was in excess of 1.0 volt; that is, the output voltage of the two batteries under no-load was from about 2.0 to about 2.2, and the voltage drop was from about 1.0 volt to about 1.7 volts.

The test also show that, when batteries have reached their exhaustion point but are allowed to rest for a few hours, their no-load output voltage will exceed 1.0 volt. However, when the batteries are then put under a load, the working voltage of the batteries rapidly drops to as low as 0.6 volt. This voltage drop can be observed because the output voltage of the batteries in the weakened condition does not drop in a single-step manner but continues to drop over time, sometimes taking as long as 30 seconds to stabilize. For example, two used DURACELL brand alkaline batteries, each having a no load output voltage of about 0.95 volt, were placed (i.e., used) in a flashlight for one hour. At the end of one hour, the no-load output voltage of the batteries was about 0.45 and 0.5 volt, respectively. The batteries were put under a load, and the voltage immediately dropped between 0.6 and 0.7 volt, for both batteries in series, and then continued to drop, over a 30 second period, for a final value, for both batteries in a series, of 0.48 volt. This same type of phenomenon was observed with the ENERGIZER alkaline batteries and with the EVEREADY brand zinc-carbon batteries. Thus, the device equipped with exhausted batteries may give a strong operation for a short period of time, but then will quickly decrease in power under the on-going load.

TABLE I
BATTERY OUTPUT VOLTAGE IN OPERATION
(Incandescent Flashlight Bulb)

Time (Hours)	Battery Voltage					
	1A	1B	2A	2B	3A	3B
0.00	1.60	1.60	1.59	1.60	1.60	1.60
1.00	1.45	1.45	1.45	1.45	1.35	1.35
1.50	1.40	1.45	1.40	1.40	1.30	1.30
2.00	1.40	1.40	1.35	1.35	1.30	1.30
2.50	1.39	1.39	1.35	1.35	1.30	1.30
3.50	1.39	1.39	1.32	1.32	1.20	1.20

TABLE I-continued

BATTERY OUTPUT VOLTAGE IN OPERATION (Incandescent Flashlight Bulb)							
Time (Hours)	Battery Voltage						
	1A	1B	2A	2B	3A	3B	
5	4.50	1.39	1.39	1.30	1.30	1.20	1.19
	5.50	1.30	1.30	1.30	1.30	1.10	1.10
	6.50	1.30	1.30	1.30	1.30	1.05	1.02
	7.50	1.30	1.30	1.29	1.29	1.01	1.01
	10.00	1.29	1.29	1.28	1.25	0.89	0.75
	11.00	1.28	1.28	1.25	1.25	0.80*	0.55*
	12.00	1.25	1.25	1.20	1.20	0.75*	0.60*
10	12.50	1.20	1.20	1.20	1.20	0.78*	0.60*
	TEST DISCONTINUED FOR 10.25 HOURS						
	15.00	1.35	1.35	1.36	1.36	1.25	1.20
	12.75	1.30	1.30	1.30	1.30	1.05	0.90
	13.00	1.29	1.29	1.28	1.26	0.95	0.75
	13.25	1.27	1.25	1.25	—	0.80	0.51
	13.50	1.26	1.25	1.25	1.25	0.89	0.70
20	14.10	1.22	1.22	1.21	1.20	0.71	0.55
	15.25	1.21	1.21	1.20	1.20	0.91	0.80
	16.25	1.21	1.20	1.18	1.18	0.61	0.40
	17.25	1.20	1.20	1.18	1.16	0.60	0.00
	18.50	1.20	1.19	1.15	1.15	DISCONTINUED	
	19.50	1.19	1.16	1.10	1.10	DISCONTINUED	
	20.50	1.13	1.11	1.10	1.10	0.99	0.81
25	22.25	1.10	1.10	1.04	1.05	0.49	0.00
	23.25	1.05	1.05	1.01	1.01	0.55	0.00
	24.50	1.05	1.05	0.89	0.93	0.80	0.00
	25.75	1.02	1.02	0.49	0.90	DISCONTINUED	
	TEST DISCONTINUED FOR 9 HOURS						
	30.00	1.19	1.20	1.20	1.20	—	—
	26.75	1.01	1.01	0.99	0.99	—	—
30	27.90	1.00	1.00	0.95	0.95	—	—
	28.50	0.99	0.99	0.85	0.86	—	—
	TEST DISCONTINUED FOR 21.5 HOURS						
	35.00	1.11	1.12	1.12	1.11	—	—
	29.50	0.99	0.99	0.90	0.89	—	—
	32.25	0.94	0.95	0.39	0.95	—	—
	TEST DISCONTINUED FOR 2 HOURS						
40	32.25	0.98	0.98	0.99*	0.90	—	—
	34.40	0.81	0.91	0.91*	0.80	—	—
	35.75	.65	.65	.65	.65	—	—
	TEST DISCONTINUED FOR 112.5 HOURS						
	35.75	1.09	1.09	1.12*	1.10	—	—
	40.35	.65	.65	.65*	.65	—	—
	TEST DISCONTINUED FOR 3.25 HOURS						
45	40.35	0.98	0.99	0.95*	0.98	—	—
	41.35	0.60	0.52	0.45*	0.54	—	—
	TEST DISCONTINUED FOR 13.75 HOURS						
	41.35	1.01	1.01	0.99*	0.97	—	—
	41.70	0.71	0.79	0.50*	0.70	—	—
	TEST DISCONTINUED FOR 2 MINUTES						
	50.00	0.90	0.91	0.80*	0.81	—	—

*Replacement for Battery 2A

Table II sets forth the measured battery voltage drop of batteries 1A, 1B, 2A, and 2B under load. The test were commenced when the batteries passed their operational half-life. As can be seen, the voltage drop of a battery under a load increased as the battery approached the end of its useful life. More indicative than the actual drop, is the amount of time it takes to stabilize the voltage under load. During the useful life of the battery, a voltage drop from the no-load voltage to the load voltage of the battery is an immediate single-step voltage drop. When the batteries are beyond their useful life, the voltage drop is a continuous, slow drop that can take some time to stabilize, sometimes exceeding 30 seconds. This is indicative that the batteries are exhausting their limited capacities.

TABLE II

BATTERY VOLTAGE DROP UNDER LOAD (Incandescent Flashlight Bulbs)						
Test Time (Hrs)	Batteries 1A & 1B			Batteries 2A & 2B		
	No Load Voltage	Voltage Under Load	Voltage Drop	No Load Voltage	Voltage Under Load	Voltage Drop
16.25	2.39	1.96	0.43	2.30	1.88	0.47
18.50	2.35	1.89	0.46	2.28	1.89	0.30
20.50	2.30	1.85	0.45	2.20	1.80	0.40
22.25	2.23	1.80	0.43	2.10	1.71	0.39
23.25	2.15	1.61	0.54	2.05	1.51	0.54
24.50	2.11	1.60	0.51	1.90	1.49	0.41
25.75	—	—	—	1.94	1.46	0.48
TEST DISCONTINUED FOR 9 HOURS						
25.75	2.32	1.70	0.62	2.35	1.75	0.60
26.75	2.08	1.40	0.68	2.01	1.52	0.49
27.90	2.02	1.40	0.62	1.82	1.30	0.52
TEST DISCONTINUED FOR 21.5 HOURS						
29.50	1.99	1.29	0.70	1.81	1.20	0.61
32.25	1.92	1.35	0.57	1.49*	0.10*	1.39*
TEST DISCONTINUED FOR 112.5 HOURS						
35.75	2.18	1.31	0.87	2.21*	1.10*	1.11*
TEST DISCONTINUED FOR 3.25 HOURS						
41.35	1.80	0.91	0.89	1.00*	0.48*	0.52*

*Replacement for Battery 2A

What is claimed is:

1. A battery having a battery strength indicating means to indicate the strength of the battery comprising a battery having a first terminal and a second terminal; a battery indicator and switch means comprising a non-conductive base layer, a non-conductive top layer disposed over the base layer, a first chamber formed between the top layer and the base layer, and a second chamber spaced from the first chamber and formed between the top layer and the base layer; indicating means disposed in the first chamber; first conductive means electrically connected to one terminal of the battery and to one end of the indicating means; second conductive means connected to the opposite end of the indicating means and extending into the second chamber; third conductive means extending from within the second chamber and extending to contact the other terminal of the battery; and whereby the second conductive means and the third conductive means in the second chamber are spaced apart and said second chamber being deformable so that upon pressing of the second chamber the second conductive means will electrically contact the third conductive means thereby placing the indicating means in electrical contact across the terminals of the battery to indicate the strength of the battery.
2. The battery of claim 1 wherein the indicating means in said first chamber undergoes a visible change when subject to at least a pre-determined voltage value.
3. The battery of claim 1 wherein at least the top layer of the first chamber is transparent.
4. The battery of claim 1 wherein at least the top layer of the first chamber is translucent.
5. The battery of claim 1 wherein the indicating means is a chemical redox composition which changes color when the voltage potential across the terminals of the battery crosses a pre-determined voltage.
6. The battery of claim 1 wherein the indicating means is a liquid crystal composition that changes pha-

ses when the electric field across the chamber exceeds a pre-determined value.

7. The battery of claim 1 wherein the second chamber upon being depressed will remain depressed thereby completing the circuit and placing the indicating means across the terminals of the cell.

8. The battery of claim 1 wherein the first conductive means comprises a conductive layer which has a reduced cross-sectional area in said first chamber and the indicating means in said first chamber comprises a heat sensitive color indicating material adapted to undergo a color change when the temperature in said first chamber rises to a pre-determined temperature when the voltage of the current flowing through the conductive layer exceeds a pre-determined value.

9. The battery of claim 1 wherein the first conductive means comprises a conductive layer which has a reduced cross-sectional area in said first chamber and wherein the indicating means comprises a pyrotechnic material adapted to decompose when the temperature of the conductive layer in said first chamber exceeds a pre-determined temperature, the conductive layer in said first chamber is adapted to exceed said pre-determined temperature when the voltage of the current through said conductive layer exceeds a pre-determined value.

10. The battery of claim 1 wherein the first conductive means comprises a conductive layer which has a reduced cross-sectional area in said first chamber such that when the voltage of the current flowing through the conductive layer in said first chamber exceeds a pre-determined value the current flowing through said conductive layer in said first chamber raises the temperature of the conductive layer in the chamber to the melting point of the conductive layer causing the conductive layer to melt at the reduced cross-sectional area.

11. The battery of claim 1 wherein the indicating means is a light emitting diode that undergoes a visible change when the voltage applied to the light emitting diode crosses a pre-determined value.

12. A battery having a battery strength indicator comprising:

a nonrechargeable dry cell battery having a first terminal and a second terminal;

a battery strength indicator formed in a layer attached to a side of said battery which undergoes a visible change when subject to a predetermined voltage output of said battery and a first conductor electrically connected between one end of said indicator and said first battery terminal; and

a battery switch comprising a resilient, nonconductive, deformable layer on a side of said battery, a switch chamber disposed beneath said resilient layer, and a second conductor

extending from said switch chamber and connected to the other end of the indicator, said portion of said second conductive lead within said switch chamber comprising a switch contact, said battery switch being biased in an electrically open position, whereby upon pressing of the resilient layer over said switch chamber, the switch contact will be placed in electrical contact with a conductive layer in electrical contact with said second battery terminal, thereby placing the indicator in electrical contact across the terminals of the battery to quickly indicate to the user the strength of the battery.

13. A voltage indicator comprising:
 A) a dielectric layer;
 B) a conductive layer above or below one of the surfaces of the dielectric layer; and
 C) a temperature sensitive color indicator material in thermal contact with the conductive layer, characterized in that the conductive layer has i) a portion of a sealed chamber, cell or bubble below one of its surfaces and ii) sufficient heat generating capacity to effect a change in the temperature sensitive color indicator material.

14. The voltage indicator of claim 13 wherein the temperature sensitive color indicator material is formed from a material which undergoes a non-permanent color change when exposed to a predetermined temperature.

15. The voltage indicator of claim 13 wherein the temperature sensitive color indicator material undergoes a

visible color change when exposed
to a predetermined temperature.

16. An article comprising
5 an integral battery voltage
indicator having:

A) a dielectric layer;
B) a conductive layer
 above or below the dielectric
 10 layer; and

15 C) a temperature sensitive
color indicator material in
thermal contact with the
conductive layer, characterized
in that:

1) the conductive layer has i) sufficient heat generating capacity to effect a change in the temperature sensitive color indicator material and ii) sufficient non-conducting means under one of its surfaces to permit the heat generated by the conductive layer to change the color of the temperature sensitive color indicator material and indicate voltage when the voltage indicator is in contact with a battery housing, and

2) the voltage indicator includes means for forming an electrical switch with an electrically conductive portion of the battery housing.

17. An article comprising an integral battery voltage indicator having a plurality of layers in the following order:

40 A) a dielectric layer;
 B) a conductive layer;
 C) one or more substrate
 layers; and

45 D) a temperature sensitive
color indicator material in
thermal contact with the
conductive layer, characterized
in that:

50 1) the conductive layer
has i) sufficient heat generating
capacity to effect a change in
the temperature sensitive color
indicator material and ii)
sufficient non-conducting means

under one of its surfaces to permit the heat generated by the conductive layer to change the color of the temperature sensitive color indicator material and indicate voltage when the voltage indicator is in contact with a battery housing, and

2) the voltage indicator includes means for forming an electrical switch with an electrically conductive portion of the battery housing.

18. An article according to claim 16 or 17 wherein the non conducting means is formed by placing a nonconductive material under the conductive layer.

19. An article according to claim 16 or 17 wherein the nonconducting means forms a sealed chamber, cell or bubble.

20. A battery having an article with an integral battery voltage indicator, wherein the voltage indicator comprises:

A) a dielectric layer;
B) a conductive layer above or below the dielectric layer; and

C) a temperature sensitive color indicator material in thermal contact with the conductive layer, characterized in that:

1) the conductive layer has i) sufficient heat generating capacity to effect a change in the temperature sensitive color indicator material and ii) sufficient non-conducting means under one of its surfaces to permit the heat generated by the conductive layer to change the color of the temperature sensitive color indicator material and indicate voltage when the voltage indicator is in contact with a battery housing, and

2) the voltage indicator includes means for forming an electrical switch with

an electrically conductive portion of the battery housing.

21. A battery having an article with an integral battery voltage indicator, wherein the integral battery voltage indicator comprises a plurality of layers in the following order:

A) a dielectric layer;
B) a conductive layer;
C) one or more substrate layers; and

D) a temperature sensitive color indicator material in thermal contact with the conductive layer, characterized in that:

1) the conductive layer has i) sufficient heat generating capacity to effect a change in the temperature sensitive color indicator material and ii) sufficient non-conducting means under one of its surfaces to permit the heat generated by the conductive layer to change the color of the temperature sensitive color indicator material and indicate voltage when the voltage indicator is in contact with a battery housing, and

2) the voltage indicator includes means for forming an electrical switch with an electrically conductive portion of the battery housing.

22. A battery according to claim 20 or 21 wherein the nonconducting means is formed by inserting a nonconductive material between the battery surface and the conductive layer.

23. A battery according to claim 21 wherein the nonconducting means comprises means for forming a sealed chamber, cell or bubble.

24. A battery with an integral voltage indicator comprising:

a battery having an anode and a cathode and being defined by a battery housing, and

55

a voltage indicator integral with said battery, said voltage indicator comprising:

a conductive layer;

5 a temperature sensitive color indicator material in thermal contact with the conductive layer wherein the conductive layer has sufficient heat generating
 10 capacity to effect a change in the temperature sensitive color indicator material;

means to prevent conduction between the conductive layer and
 15 the battery housing to permit the heat generated by the conductive layer to change the color of the temperature sensitive color indicator material and indicate
 20 voltage when the voltage indicator is in contact with a battery housing; and

electrical switch means positioned, when activated, to
 25 electrically connect the conductive layer and a conductive portion of the battery housing to effect a color change in the temperature sensitive color
 30 indicator material.

25. A battery according to claim 24, wherein the conductive layer has a portion reduced to a small cross sectional area and is
 35 positioned so that current can flow between the conductive layer and reduced cross section area when the electrical switch means is activated, wherein the extent
 40 to which the conductive layer is heated at the reduced cross sectional area is related to the battery's voltage and the extent to which the temperature
 45 sensitive color indicator material undergoes a color change indicates the voltage and level of heating.

26. A battery according to claim 24, wherein the means to
 50 prevent conduction is a nonconductive material.

27. A battery according to claim 24, wherein the means to
 55

prevent conduction comprises a sealed chamber, cell or bubble.

28. A battery according to claim 24, wherein the temperature sensitive color indicator material is formed from a material which undergoes a non-permanent color change when exposed to a predetermined temperature.

29. A battery according to claim 24, wherein the temperature sensitive color indicator material undergoes a visible color change when exposed to a predetermined temperature.

30. A voltmeter comprising:
A) a dielectric layer;
B) a conductive layer above or below one of the surfaces of the dielectric layer; and

C) a temperature sensitive color indicator layer in thermal contact with the conductive layer, characterized in that the conductive layer has i) an air pocket under one of its surfaces and ii) sufficient heat generating capacity to affect a change in the temperature sensitive color indicator layer.

31. The voltmeter of claim 30 wherein the insulating means is formed by placing a temperature insulating material under the conductive layer.

32. The voltmeter of claim 30 wherein the color indicator layer changes from:

A) a color to colorless;
B) colorless to a color;

or

C) one color to a second color.

33. A label comprising an integral battery voltmeter having:

A) a dielectric layer;
B) a conductive layer above or below the dielectric layer; and

C) a temperature sensitive color indicator layer in thermal

contact with the conductive layer, characterized in that 1) the conductive layer has i) sufficient heat generating capacity to affect a change in the temperature sensitive color indicator layer and ii) sufficient thermal insulating means under one of its surfaces to overcome heat sinking when the voltmeter is in contact with a battery having an electrically conductive housing and 2) the voltmeter includes means for forming an electrical switch with the electrically conductive battery housing.

34. A label comprising an integral battery voltmeter having a plurality of layers in the following order:

A) a dielectric layer;
B) a conductive layer;
C) one or more substrate layers for the label;

D) a temperature sensitive color indicator layer; and characterized in that 1) the conductive layer has i) sufficient heat generating capacity to affect a change in the temperature sensitive color indicator layer and ii) sufficient thermal insulating means under one of its surfaces to overcome heat sinking when the voltmeter is in contact with a battery having an electrically conducting housing and 2) the voltmeter includes means for forming an electrical switch with the electrically conductive battery housing.

35. A label according to claim 33 or 34 wherein the temperature insulating means is formed by placing a temperature insulating material under the conductive layer.

36. A label according to claim 33 or 34 wherein the temperature insulating means forms an air pocket.

37. A battery having a label with an integral voltmeter; wherein the voltmeter comprises:

- A) a dielectric layer;
- 5 B) a conductive layer above or below the dielectric layer; and
- C) a temperature sensitive color indicator layer in thermal
- 10 contact with the conductive layer, characterized in that 1) the conductive layer has i) sufficient heat generating capacity to affect a change in
- 15 the temperature sensitive color indicator layer and ii) sufficient thermal insulating means under one of its surfaces to overcome heat sinking when the
- 20 voltmeter is in contact with a battery having an electrically conducting housing and 2) the voltmeter includes means for forming an electrical switch with
- 25 the electrically conductive battery housing.

38. A battery having a label with an integral voltmeter; wherein the voltmeter comprises a

30 plurality of layers in the following order;

- A) a dielectric layer;
- B) a conductive layer;
- C) one or more substrate
- 35 layers for the label; and
- D) a temperature sensitive color indicator layer, characterized in that 1) the
- 40 conductive layer has i) sufficient heat generating capacity to affect a change in the temperature sensitive color indicator layer and ii)
- 45 sufficient thermal insulating means under one of its surfaces to overcome heat sinking when the voltmeter is in contact with a battery having an electrically
- 50 conducting housing and 2) the voltmeter includes means for forming an electrical switch with the electrically conductive battery housing.

5 39. A battery according to
claim 37 or 38 wherein the
insulating means is formed by
inserting a temperature
insulating material between the
10 battery surface and the
conductive layer.

15 40. A battery according to
claim 38 wherein insulating means
is an air pocket under the
dielectric substrate under the
area of the conductive layer.

20 41. The voltmeter of claim
30 wherein the temperature
sensitive color indicator layer
is formed from a color reversible
temperature sensitive material
selected from the group
consisting of thermochromic inks,
liquid crystalline material and
25 thermochromic inks, liquid
crystalline materials and
thermochromic tapes.

30 42. The voltmeter of claim
30 wherein the temperature
sensitive color indicator layer
changes from:

35 A) a color to colorless;
B) colorless to a color;
or
C) one color to a second
color.

40 43. A battery according to
claim 38 wherein the thermal
insulating means comprises means
for forming an air pocket under
the dielectric layer.

45 44. A battery with an
integral voltmeter comprising:
a battery having terminals of
opposite polarity and being
defined by a battery can and
a voltmeter integral with said
battery, said voltmeter
comprising:

50 a conductive layer;
a temperature sensitive
color indicator layer in thermal
contact with the conductive
layer, wherein the conductive
55 layer has sufficient heat
generating capacity to effect a
change in the temperature
sensitive color indicator layer;

means to provide thermal insulation between the conductive layer and the battery can to prevent the battery from acting as a heat sink for the conductive layer; and electrical switch means positioned, when activated, to couple electrically the conductive layer and the battery can so that current may flow through the conductive layer to effect a color change in the temperature sensitive color indicator layer.

45. A battery according to claim 44, wherein the conductive layer has a narrow portion which widens along at least part of the conductive layer to a wide portion and is positioned so that current can flow between the narrow and wide portions when the electrical switch means is activated, wherein the extent to which the conductive layer is heated between the wide and narrow portions is related to the battery's voltage and the extent to which the temperature sensitive color indicator layer undergoes a color change indicates the voltage and level of heating.

46. A battery according to claim 44 wherein the means to provide thermal insulation is a thermal insulation material.

47. A battery according to claim 44, wherein the means to provide thermal insulation comprises standoffs on the dielectric layer adjacent the battery can, wherein the standoffs, the dielectric layer, and the battery can define an air pocket.

48. A battery according to claim 44 wherein the temperature sensitive color indicator layer is formed from a color reversible temperature sensitive material selected from group consisting of thermochromic inks, liquid

crystalline materials, and thermochromic tapes.

49. A battery according to claim 44 wherein the temperature sensitive color indicator layer changes from:

- A) a color to colorless;
- B) colorless to a color;

or

C) one color to a second color.

50. An article comprising an integral battery voltage indicator having:

- A) a dielectric layer;
- B) a conductive layer above or below the dielectric layer; and

C) a temperature sensitive color indicator material in thermal contact with the conductive layer, characterized in that:

1) the conductive layer has i) sufficient heat generating capacity to effect a change in the temperature sensitive color indicator material and ii) coupling means to permit the heat generated by the conductive layer to change the color of the temperature sensitive color indicator material and indicate voltage when the voltage indicator is in contact with a battery housing, and

2) the voltage indicator includes means for forming an electrical switch with an electrically conductive portion of the battery housing.

45

50

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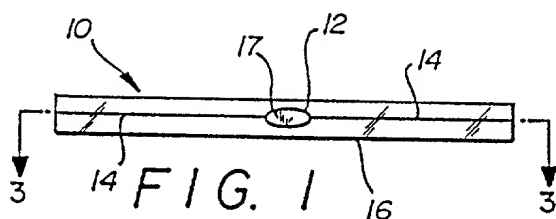


FIG. 1

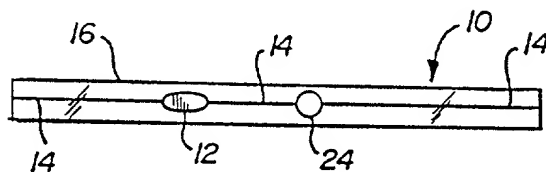


FIG. 1A

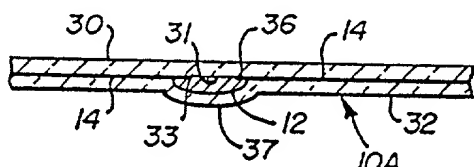


FIG. 3

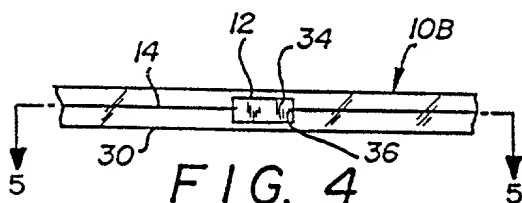


FIG. 4

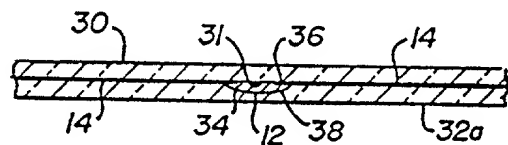


FIG. 5

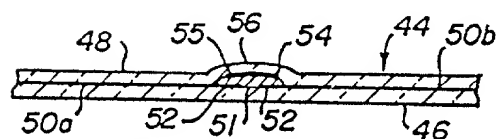


FIG. 6

FIG. 2

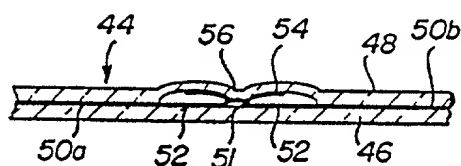
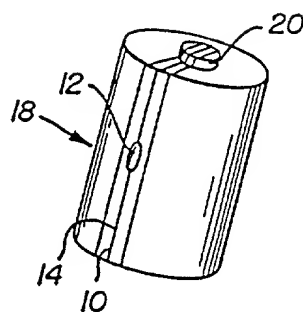


FIG. 7

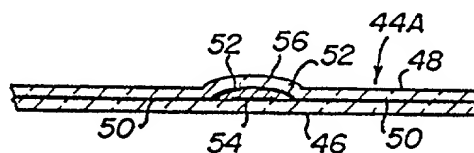


FIG. 8

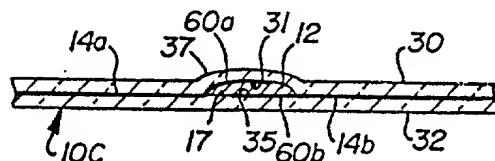


FIG. 9

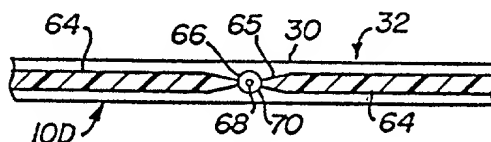


FIG. 10

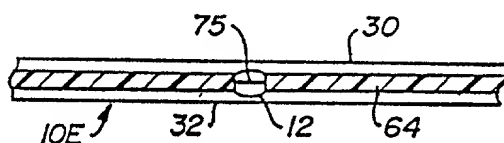


FIG. 11

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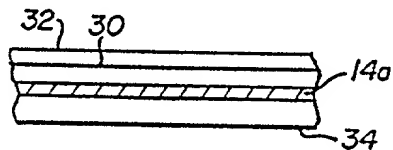


FIG. 14

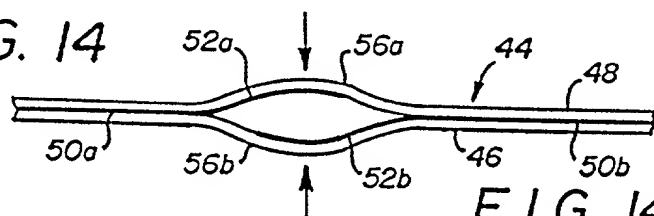
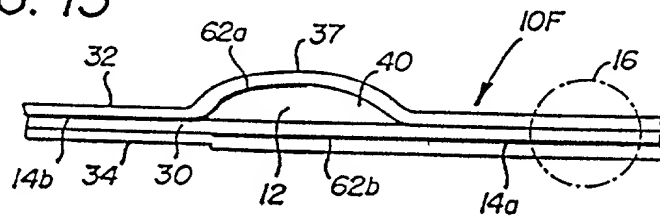


FIG. 14

FIG. 15



PATENT

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In re Application of: James R. Burroughs)
 and Alan N. O'Kain)
Serial No: 308,210) Art Unit: 114
Filed: February 8, 1989)
For: BATTERY WITH STRENGTH INDICATOR) Examiner:
Reissue of U.S. Patent No. 5,015,544)
Issued: May 14, 1991)
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REISSUE DECLARATION AND POWER OF ATTORNEY

Applicants, James R. Burroughs and Alan N. O'Kain, citizens of the United States of America, declare that:

1. We reside respectively at 4697 White Oak Avenue, Encino, California 91316 and 718 Malabar Drive, Corona del Mar, California 92625.

2. We believe that we are the original, first and joint inventors of the subject matter described and claimed in U.S. Letters Patent No. 5,015,544 granted on May 14, 1991 and in the attached specification for which invention we solicit a reissue patent.

3. We do not know and do not believe that the invention was ever known or used in the United States before our invention thereof.

4. We hereby state that we have received and understand the contents of the attached specification and claims of this reissue application.

5. We acknowledge our duty to disclose information which is material to the examination of this application in accordance with Section 1.56(a) of Title 37, Code of Federal Regulations.

6. We believe our original patent, U.S. Patent No. 5,015,544, to be partly or wholly inoperative because of error, without deceptive intent on part of the applicants, by reason of claiming less than we had a right to claim in the patent. Specifically, claims 1-11 as issued in our patent are limited to a battery having a battery strength indicator and switch means in which the battery indicator means is defined as a first chamber having indicating means therein formed between top and base nonconductive layers, the switch means is defined as a deformable second chamber formed between the top and base layers, and including first, second and third conductive means.

7. After becoming aware in late 1991 of U.S. Patent No. 5,059,895, issued on October 22, 1991 to Cataldi et al., we initiated review of the subject matter of claims 1-11 of our patent with our current patent attorney, Peter W. Peterson, who took over responsibility for the patent after it was allowed and issued. After reviewing these matters with Mr. Peterson, we began to realize that the inventive concept of the battery strength or voltage indicator disclosed in our patent does not require recitation of the specific construction of the battery indicator and switch means, or even the battery, as set forth in claims 1-11.

8. In a first aspect, we began to realize after review of the Cataldi et al. patent that the inventive concept of our patent does not require recitation of the specific construction of the battery indicator means as comprising a first chamber formed between top and base nonconductive layers and indicator means disposed therein, as set forth in claims 1-11. Instead, we believe this aspect of our inventive concept is broader in scope and requires only recitation of a battery strength indicator formed in a layer attached to a side of the battery

which undergoes a visible change when subject to a predetermined voltage output of the battery and a battery switch biased in an open position comprising a resilient, nonconductive, deformable layer on a side of the battery with a switch chamber disposed beneath the resilient layer, and the conductors electrically connecting the strength indicator and the switch chamber with each other and the battery terminals. To protect this aspect of the inventive concept of our patent, new claim 12 is set forth in this reissue application which eliminates the specific construction of the battery indicator means as recited in our original patent claims 1-11.

9. In another aspect, we began to realize after review of the Cataldi et al. patent that the inventive concept of our patent does not require recitation of the battery or the battery switch means, as set forth in claims 1-11. Instead, we believe this aspect of our inventive concept is broader in scope and requires only recitation of a voltage indicator comprising a dielectric layer; a conductive layer above or below one of the surfaces of the dielectric layer; and a temperature sensitive color indicator layer or material in thermal contact with the conductive layer, characterized in that the conductive layer has an air pocket such as a portion of a sealed chamber, cell or bubble below one of its surfaces and sufficient heat generating capacity to effect a change in the temperature sensitive color indicator material, where optionally the temperature sensitive color indicator material is formed from a material which undergoes a non-permanent or visible color change when exposed to a predetermined temperature or may undergo a visible color change when exposed to a predetermined temperature. To protect this aspect of the inventive concept of our patent, new claims 13-15 are set forth in this reissue application which eliminate the battery and the battery switch means as recited in our original patent claims 1-11. At the same time, we realized that

this aspect of the inventive concept of our patent was set forth in claims 1-10 of the Cataldi et al. patent, and that our patent provided a basis to support and copy claims 1, 6 and 7 of the Cataldi et al. patent, which we have done and set forth as new claims 30-32 of this reissue application, which are directed to the same or substantially the same subject matter as claims 13 and 15. As such, claims 13-15 and 30-32 of this reissue application are presented at least in part to provoke an interference with the Cataldi et al. patent.

10. In a further aspect, we began to realize after review of the Cataldi et al. patent that the inventive concept of our patent does not require recitation of the battery or the specific construction of the battery switch means as comprising a deformable second chamber formed between top and base nonconductive layers, and spaced apart conductive means within the chamber which may be brought into contact by pressing the chamber, as set forth in claims 1-11. Instead, we believe this aspect of our inventive concept is broader in scope and requires only recitation of a label or article comprising an integral battery voltage indicator having a dielectric layer; a conductive layer above or below the dielectric layer; and a temperature sensitive color indicator layer or material in thermal contact with the conductive layer, characterized in that the conductive layer has sufficient heat generating capacity to effect a change in the temperature sensitive color indicator material and sufficient coupling means or non-conducting or thermal insulating means under one of its surfaces to overcome heat sinking and permit the heat generated by the conductive layer to change the color of the temperature sensitive color indicator material and indicate voltage when the voltage indicator is in contact with a battery housing, which is normally electrically conductive, and the voltage indicator includes means for forming an electrical switch with an electrically conductive portion of the battery housing, and where, optionally, the nonconducting or temperature

insulating means is an air pocket, sealed chamber, cell, bubble or layer of nonconductive or temperature insulating material, and the label or article has a plurality of layers in the order recited, including one or more substrate layers between the conductive layer and the temperature sensitive color indicator layer or material. To protect this aspect of the inventive concept of our patent, new claims 16-19 and 50 are set forth in this reissue application which eliminate the battery and the specific construction of the battery switch means as recited in our original patent claims 1-11. At the same time, we realized that this aspect of the inventive concept of our patent was set forth in claims 11-19 of the Cataldi et al. patent, and that our patent provided a basis to support and copy claims 11, 12, 18 and 19 of the Cataldi et al. patent, which we have done and set forth as new claims 33-36 of this reissue application, which are directed to the same or substantially the same subject matter as claims 16-19. As such, claims 16-19, 33-36 and 50 of this reissue application are presented at least in part to provoke an interference with the Cataldi et al. patent.

11. In yet another aspect, we began to realize after review of the Cataldi et al. patent that the inventive concept of our patent does not require recitation of the specific construction of the battery switch means as comprising a deformable second chamber formed between top and base nonconductive layers, and spaced apart conductive means within the chamber which may be brought into contact by pressing the chamber, as set forth in claims 1-11. Instead, we believe this aspect of our inventive concept is broader in scope and requires only recitation of a battery having a label or article with an integral battery voltage indicator having a dielectric layer; a conductive layer above or below the dielectric layer; and a temperature sensitive color indicator layer or material in thermal contact with the conductive layer, characterized in that the conductive layer has

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sufficient heat generating capacity to effect a change in the temperature sensitive color indicator material and sufficient non-conducting or thermal insulating means under one of its surfaces to overcome heat sinking and permit the heat generated by the conductive layer to change the color of the temperature sensitive color indicator material and indicate voltage when the voltage indicator is in contact with a battery housing, which is normally electrically conductive, and the voltage indicator includes means for forming an electrical switch with an electrically conductive portion of the battery housing, and where, optionally, the nonconducting or temperature insulating means is an air pocket, sealed chamber, cell, bubble or layer of nonconductive or temperature insulating material, and the label or article has a plurality of layers in the order recited, including one or more substrate layers between the conductive layer and the temperature sensitive color indicator layer or material. To protect this aspect of the inventive concept of our patent, new claims 20-23 are set forth in this reissue application which eliminate the specific construction of the battery switch means as recited in our original patent claims 1-11. At the same time we realized that this aspect of the inventive concept of our patent was set forth in claims 20-29 of the Cataldi et al. patent, and that our patent provided a basis to support and copy claims 20, 21, 28 and 29 of the Cataldi et al. patent, which we have done and set forth as new claims 37-40 of this reissue application, which are directed to the same or substantially the same subject matter as claims 20-23. As such, claims 20-23 and 37-40 of this reissue application are presented at least in part to provoke an interference with the Cataldi et al. patent.

12. The true and broader scope of the inventive concept of our patent, as we now understand it to be in the aforementioned aspects, became more fully appreciated by us in mid-1992 after

13. In September of 1992, we became aware of a reissue application filed for the Cataldi et al. patent and further realized that the inventive concept of our patent does not require recitation of the specific construction of the battery switch means as comprising a deformable second chamber formed between top and base nonconductive layers, and spaced apart conductive means within the chamber which may be brought into contact by pressing the chamber, as set forth in claims 1-11. Instead, we believe this aspect of our inventive concept is broader in scope and requires only recitation of a battery having with an integral battery voltage indicator comprising a battery having terminals of opposite polarity and being defined by a battery housing or can, and a voltage indicator, integral with the battery, comprising a conductive layer; a temperature sensitive color indicator layer or material in thermal contact with the conductive layer wherein the conductive layer has sufficient heat generating capacity to effect a change in the temperature sensitive color indicator material; means to provide thermal insulation and prevent conduction between the conductive layer and the battery housing to prevent the battery from acting as a heat sink for the conductive layer and permit the heat generated by the conductive layer to change the color of the temperature sensitive color indicator material and indicate voltage when the voltage indicator is in contact with a battery housing; and electrical switch means positioned, when activated, to electrically connect the conductive layer and a conductive portion of the battery housing or can to effect a color change

in the temperature sensitive color indicator layer or material. To protect this aspect of the inventive concept of our patent, new claims 24-29 are set forth in this reissue application which eliminate the specific construction of the battery switch means as recited in our original patent claims 1-11. At the same time we realized that this aspect of the inventive concept of our patent was set forth in claims 30-39 of the Cataldi et al. reissue application, and that our patent provided a basis to support and copy claims 30, 31, 35, 36, 37 and 39 of the Cataldi et al. reissue application, which we have done and set forth as new claims 44-49 of this reissue application, which are directed to the same or substantially the same subject matter as claims 24-29. Additionally, we have copied claims 3, 7 and 29 of the Cataldi et al. reissue application, which we have set forth as claims 41-43, and have set forth the same or substantially the same subject matter in claim 14. As such, claims 14, 24-29 and 41-49 of this reissue application are presented at least in part to provoke an interference with the Cataldi et al. reissue application.

14. We have been informed by our current attorney, Peter W. Peterson, that the aforementioned errors render claims 1-11 of our patent wholly or partly inoperative by reason of claiming less than we were entitled to claim in view of the claims issuings to Cataldi et al. of U.S. Patent No. 5,059,895, which claims the same or substantially the same subject matter as disclosed in our patent. We are presenting claims 13-49 herein in part for the purpose of requesting an interference with U.S. Patent No. 5,059,895 and the reissue application for such patent, which claims are supported by the disclosure of our patent and which we believe are new and not obvious from the prior art of which we are aware.

15. We believe that the errors which render our patent wholly or partly inoperative arose from inadvertence, accident

or mistake, and without any fraudulent or deceptive intention on our part. The reasons for the errors constituting such inadvertence, accident, and mistake were that we failed to communicate the inventive concept of our battery strength indicator properly to our original Attorney, William G. Lane, who we engaged to prepare and file our patent application. We also failed to communicate the inventive concept of our battery strength indicator to Attorney Cornelius F. O'Brien, who we subsequently engaged for substantive prosecution of our patent application and who obtained allowance of the application. In this regard, it should be noted that Mr. O'Brien agreed to take on and first saw our application several weeks after the office action dated February 9, 1990, and so he did not have the benefit of the full background of preparing and filing the application. Further, we both reside in California and Mr. O'Brien resides in Connecticut, and all communication with Mr. O'Brien was by telephone, which probably contributed to the error in communication. In addition, we did not adequately understand the unduly limiting effect of the specific recited features of the battery, strength indicator means and switch means in claims 1-11 of said patent because we are not familiar with patent law. Accordingly, this reissue patent application to obtain a broader scope of protection than that of claims 1-11 of said patent is believed proper in that the features in the claims of narrower scope in our patent are not essential for practicing the broad inventive concept disclosed therein, the claims of our patent are unduly narrow, and the errors in the original patent arose without fraudulent or deceptive intention on the part of the applicants. As to claims 1-11 of our patent, we believe that new claims 12-50 correct the inoperability defect since they claim our inventive concept more broadly by variously eliminating the requirements of the battery, specific battery indicator means construction and/or specific switch means construction, as described above.

16. The undersigned applicants declare further that all statements made herein of our own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements are made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

We hereby appoint Anthony P. DeLio, Reg. No. 18,729, and Peter W. Peterson, Reg. No. 31,867, of the firm of DeLio & Associates in New Haven, Connecticut, and John H. Mion, Reg. No. 18,879, of the firm of Sughrue, Mion, Zinn, MacPeak & Seas in Washington, D.C., our attorneys to prosecute this application and to transact all business in the United States Patent and Trademark Office connected therewith. Send all correspondence to:

Peter W. Peterson
DeLio & Associates
121 Whitney Avenue
New Haven, Connecticut 06510.

Wherefore, we hereby subscribe our names to the foregoing Reissue Application, Declaration and Power of Attorney.

10/13/92
Date

10-13-92
Date

James R. Burroughs

Alan N. O'Kain